PLANT ITEM MATERIAL SELECTION DATA SHEET

R10591354

HLP-VSL-00022 (PTF)
HLW Feed Receipt Vessel

- Design Temperature (°F) (max/min): 215/40
- Design Pressure (psig) (max/min): 15/-4.5
- Location: incell
- PJM Discharge Velocity (fps): 26
- Drive Cycle: 33 % (at 26 fps)

Related Plant Items

HLP-PJM-00056 – HLP-PJM-00057
HLP-PJM-00084 – HLP-PJM-00093

ISSUED BY
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 6 and 7

Operating Modes Considered:

- Normal operating conditions
- The vessel will be cleaned using process condensate, 2M NaOH or 2 M HNO_3 with residual chlorides and fluorides at 113 °F. The condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection is required as discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

This vessel receives Tank Farm waste having a temperature or solids content above acceptable levels for the waste feed receipt vessels (FRP-VSL-00002A/B/C/D). The vessel is equipped with a cooling jacket to keep the temperature at 113°F or below.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He states 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at temperatures up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures of about 122°F. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F. Studies have shown that in simulated waste at 140°F, 304L, with a corrosion rate < 1 mpy, performed slightly better than 316L – possibly due to the presence of nitrate. In this system, the hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable. If the alkaline waste reaches boiling, other work suggests that 304L would be acceptable, probably due to the presence of nitrate. Normally a high nickel alloy such as Inconel 600 would be required for hot caustic.

Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning unless the fluoride is well inhibited. Keeping the vessel as cool as possible, below 100°F, would reduce the extent of attack by chloride (pitting and crevice corrosion) and, and with the addition of Al^{++}, general corrosion due to fluoride. 304L will be suitable if properly protected by temperature and fluoride complexants such as Al^{+++}. The less control of the acid conditions, the more consideration that will have to be given to more corrosion resistant alloys.

Conclusion:
At temperatures less than about 140°F, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Even considering acid cleaning, 316L will be acceptable if rinsing procedure is developed to reduce the effects of fluoride during acid conditions

b Pitting Corrosion
Chloride is known to cause pitting of stainless steel and related alloys in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (2000) has stated that localized corrosion can occur under the waste deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 113°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions at the upper pH values. The condition of solids and deposits present during possible acid cleaning means that 316L is the lowest alloy to be used. Even then, flushing will be required.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water, which tends to be dirtier, and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain and to concentrate.

Conclusion:
Based on the expected operating conditions, 316L is expected to be satisfactory at the stated operating temperature and if the pH is neutral or higher and if the duration and extent of possible low pH off-normal conditions and acid cleaning are controlled.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment, but also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. With the stated low operating temperature and alkaline conditions, 304L is expected to be satisfactory. However, because of the possibility of acid cleaning, 316 L will be the minimum acceptable alloy.

Conclusion:
The minimum alloy recommended is a 316L stainless steel.

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e Crevice Corrosion
See Pitting

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is generally too alkaline. The use of untreated process water may be a concern. The use of DIW is recommended.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Typically not a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether the vessel, and particularly the lid, will be sufficiently washed or whether residual acids or solids will be present. In the former case, 304L would be satisfactory. If solids or acids and solids are present, a 316L or better is preferred.

Conclusion:
316L is recommended.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 8 m/s with solids concentrations of 26.46 wt% for a usage of 100 % operation as documented in 24590-WTP-M0E-50-00003. HLP-VSL-00022 requires at least 0.398-inch additional protection. The 26.46 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of HLP-VSL-00022 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.357–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 26.46 wt% for usage of 100 % operation as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
No moving surfaces within the vessel.
Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

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n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

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References:

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24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) HLW feed receipt vessel (HLP-VSL-00022)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.97E+01	3.01E+01			
Chloride	g/l	7.84E-01	7.84E-01			
Fluoride	g/l	2.12E-01	2.12E-01			
Iron	g/l	5.72E+01	5.72E+01			
Nitrate	g/l	7.14E+01	7.14E+01			
Nitrite	g/l	6.09E+00	6.09E+00			
Phosphate	g/l	8.51E+00	8.51E+00			
Sulfate	g/l	2.12E+00	2.12E+00			
Mercury	g/l	1.97E-01	1.97E-01			
Carbonate	g/l	9.98E+01	9.98E+01			
Undissolved solids	wt%	26.46%	26.46%			
Other (NaMnO4, Pb,...)	wt%					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-HLP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: FRP14, HLP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID:
PFD: 24590-PTF-M5-V17T-P0007, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T operation mode 1: 113 °F to 190 °F, T operation mode 2: 68 °F to 86 °F (24590-MVC-HLP-00001, Rev 0)
3. pH approximately 13 to 14

Assumptions:

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4.6.2 HLW Feed Receipt Vessel (HLP-VSL-00022)

Routine Operations

High-level waste feed from the Tank Farms is received into the HLW feed receipt vessel (HLP-VSL-00022). Tank Farm waste that has a temperature or solids content above the criteria for vessels FRP-VSL-00002A/B/C/D, which receive LAW waste from tank farms, can be sent to vessel HLP-VSL-00022. Once receipt is complete, sampling for confirmation of waste acceptance will begin. Sampling for criticality is required for HLW feed receipt. The HLW feed is sampled for waste concentration. The waste concentrations must be below the acceptable criticality limits. The vessels are equipped with cooling jackets to maintain the temperature at or below 113 °F. During this staging period, PJMs will operate to provide sufficient mixing within the vessels, and the recirculation pump will run to maintain a flooded suction line. When required, HLW feed will be transferred for processing. HLW feed may be fed to one of three systems for processing: 1) the waste feed evaporation process system (FEP), 2) the ultrafiltration process system (UFP), or 3) the waste feed receipt process system (FRP), for evaporation, filtration, or blending, respectively. This will be determined by the current plant status and will be evaluated on a case-by-case basis during plant operations.

Non-Routine Operations that Could Affect Corrosion/Erosion

This vessel overflows to PWD-VSL-00033.

There is also the option to return HLW feed from the HLW feed receipt vessel back to the Tank Farms via the waste feed return pump, FRP-PMP-00001, in system FRP. This is the case when the HLW feed does not meet the requirements of the specification for HLW feed. However, this is considered an infrequent event.